Quarterly Report #4

Development of Hand-held Thermographic Inspection Technologies
RI06-038

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Reporting period: December, 2007 thru February, 2008
Summary of Accomplishments and Activities

Work this quarter continued on Task 1, *Preliminary Study Development*, and this task is coming to a close with the delivery of the field data acquisition system planned for April, 2008. Efforts on Task 2, Controlled Testing of Concrete Test Specimen, are ongoing and results will be presented in this report. Significant progress in moving onto Task 3, *Operational Testing*, have been made and the delivery of cameras to States for field testing of the systems has begun.

1. Development of Field Data Acquisition System (FDAS)

The development of a field data acquisition system (FDAS) has continued this quarter, though efforts in this area have been limited to finalizing the assembly of one device for transfer to States. Based on previous discussions in quarterly teleconferences, a single prototype FDAS has been manufactured. This system will provide an evaluation platform for study participants to explore the utility of this device. This prototype can be easily replicated, and may even be improved through some field experience. The final cost of the FDAS is approximately $1500 when utilizing a cellular modem for communications. The ultra-portable computer that provides the user interface for the device crashed and required replacement from the manufacturer under warranty, which has provided some delay in finalizing the FDAS. Delivery is planned for April.

2. Test Block

The test block including targets at depths of 1, 2, 3 and 5 in. has been completed and 3 months of data was collected on the south side of the block, which is exposed to the sun on a daily basis. The months of November, December and January have complete and valid datasets and these months are being used for analysis. Data from October is intermittent and sporadic due to initial debugging of the data acquisition system. The results of this test period are being evaluated. Correlation models to determine the ideal

combination of solar loading (sun), wind, humidity and variations in ambient temperature are being developed. Initial analysis of the results are discussed in the following section.

The data acquisition test house was moved at the end of January and relocated to the North side of the block. Data acquisition on the north side of the block was initiated at the beginning of February and is ongoing.

Initial results will be presented more thoroughly during the schedule conference call. Figure 1 (A-D) below shows an example of one week of the data being analyzed. In each figure, the thermal contrast between target locations (1,2,3 and 5 in. depth) and a sound location on the block is shown corresponding to the values shown on the left axis. A negative value indicates the target appears as a cold spot on the block, positive values indicate that the target appears warmer than that surrounding areas of the block. Figure 1A shows the ambient temperature of the environment. Figure 1B shows the solar loading, 1C the average windspeed, and 1D the relative humidity.

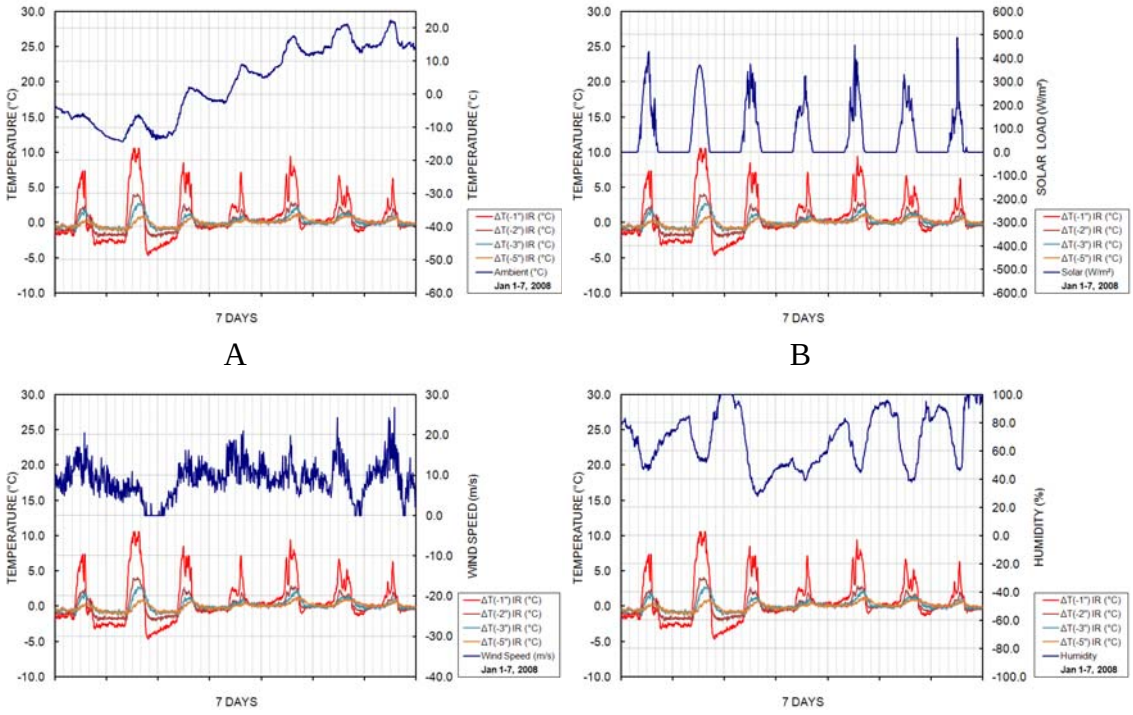

Figure 2. One-week graph of weather parameters vs. thermal contrast at target locations in test block. Graph 2A shows the ambient temperature; 2B shows the solar loading; 2C shows the average windspeed and 2D shows the relative humidity.

A shown in Figure 2, the solar loading appears to be the predominant effect governing the thermal contrast for the embedded targets in the test block. This is not unexpected, but this data provides quantitative measures that have been previously unavailable. Figure 3 shows a scatter plot of the solar loading power, which is calculated as the total area under the curve shown in figure 2B, against the thermal contrast for a target located at a depth of 2 inches. There is a strong correlation between the thermal contrast and the solar loading power as shown in the figure. Current efforts on the project are examining the interaction of the four environmental parameters to develop a model on which to base guideline recommendations for determining the ideal environmental conditions for conducting inspections using IR for surface exposed to direct sunlight.

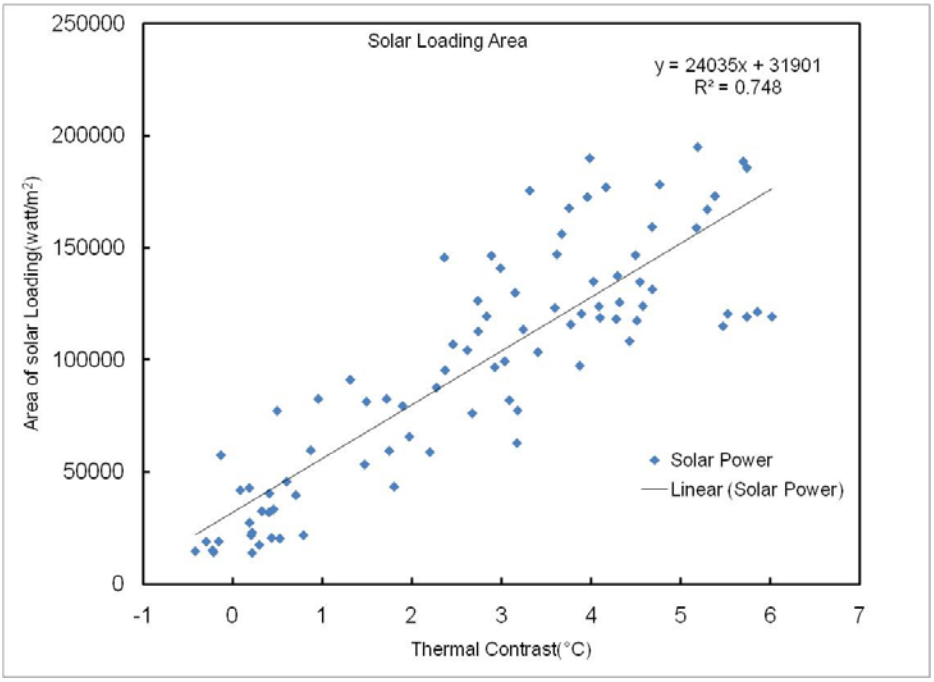

Figure 3. Scatter plot of thermal contrast for the 2" deep target against the solar loading power, or the area under the curve, for figure 2B.

Task 3. Operational Testing

Three B-400 thermal cameras have been procured and are ready to be delivered to the States. Six training modules have been developed for training DOT participants in the use of the camera and the theoretical aspects of IR testing. The six training modules are:

Training Module 1: Project Introduction and Training Overview
Training Module 2: Introduction to Infrared Radiation
Training Module 3: Basics of Heat Transfer
Training Module 4: Making a Good Image
Training Module 5: Research and Recommendations
Training Module 6: Camera Operations

Participant notebooks that includes printed versions of the training modules with adequate space for notetaking was developed as part of the training course. Additionally, a concise user guide was developed to assist users in quickly learning camera functions. A single-sheet, laminated guide was also developed to be taken into the field along with the camera to provide rapid access to information on camera features.

A B-400 camera, supporting software, and the users guides were delivered to the State of Texas on March 25, 2008. Training was provided to TXDOT representative and a field demonstration was conducted. Figure 4 shows a photograph from the field testing.

Due to the simplicity and revised data format for the new IR cameras, transmittal of results from operational testing can simply be e-mailed to the PI for review and analysis. Previous plans to established a fixed data transfer point, such as and FTP site, seem unnecessary at this time, but if it becomes advantageous to establish such a site, it can be done in a matter of hours. The resource exists and providing the project team with a password and URL is all that is required. However, this additional level does not seem to be necessary. A more standardized list of information to put in the description field for the report software is needed and will be provided by the PI.

Figure 4. Photograph of field testing of the IR cameras in Texas.

4. Issues or Problems that need to be addressed.

There has been an impact on the overall budget as a result of procuring four hand-held cameras rather than the three originally planned. This issue may need to be addressed in the future, when the effect on the scope of the project, if any, can be understood. Operational issues with the B-400 camera scheduled to be delivered to NY are being investigated. This camera has already been returned to the manufacturer once for service. This is causing a delay in getting the camera into operational testing.

Schedule

The project is presently approximately 2 or 3 months behind the original schedule. At this point, this delay is not expected to effect the completion date for the project, however it would reduce the time involved with operational testing below what was originally envisioned. However, this will likely not affect the achievement of the goals of the project. No-cost extension of the project is an option if necessary.

Table 1. Summary of project schedule.

		Months																						
	Tasks	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J
1	Preliminary Study Development	■	■	■	■	■	■																		
2	Controlled Testing of Concrete Specimen							■	■	■	■	■	■	■	▨	■	■	■	■						
3	Operational Testing										■	■	■	■	▨	■	■	■	■	■	■	■			
4	Final Report																			■	■	■	■	■	■

% of Budget Expended: Approximately 90% of the funding provided by the participating States has been expended. Approximately 90% of the University-provided funded has been expended. Less than 10% of the University Transportation Center budget has been expended, because it has only recently become available.